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A Silver Transformation: Chinese Monetary Integration in Times of Political Disintegration during 1898–1933[*]

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Abstract:
This paper provides the first systematic econometric study on the evolution of Chinese silver exchange and monetary regimes during 1898–1933. Using high quality data sets of monthly and daily prices of silver dollars, we apply the threshold autoregressive models to estimate the silver points between Shanghai and other seventeen cities in Northern and Central China. We find a dramatic improvement in monetary integration from the 1910s, consolidated throughout the 1920s and 1930s to rival the global standard. We supplement our analysis with new data sets on volumes and costs of silver flows and with an in-depth historical narrative. Our paper revaluates the efficiency of the silver regime and China's economic performance in the Republican era.

1. Introduction

Whether the 1842 Sino-British Opium War and the forced opening of Qing China to Western imperialism and global trade marked the beginning of a century of Chinese humiliation or era of awakening to modernity may be a matter of perspectives. But the era of 1898–1933, covered in this study, saw China's best and worst of times, straddling several sub-periods of a tumultuous era in modern Chinese history. It started with China's disastrous military defeat by Japan in

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1894–95 and then by Western (and Japanese) allied forces over the suppression of the Boxer Rebellion in 1901. In the wake of this defeat, Qing embarked on a bold modernization reform in 1905, modelled after Japan's Meiji Restoration, but only to collapse in 1911. China's subsequent Republican era (1911–49) begins with the Beiyang decades of 1911–27—also known as the Warlord Era—ruled by the so-called Northern regime in Beijing.[1] It is followed by the Nanjing Decade led by the Nationalist Government based in the capital of Nanjing, only to be disrupted by a full scale Japanese invasion in 1937.

In spite of the political turmoil, this era also saw fundamental economic and industrial transformations (Brandt, Ma, and Rawski, 2014). But the monetary and financial aspect of this transformation is still relatively little understood. Throughout this period, China remained the large silver outlier at a time when most of the world were aspiring to join the gold club for prestige and respectability (for example, Bordo and Rockoff, 1996; Meissner, 2005; Mitchener, Shizume, and Weidenmier, 2010). The Chinese adherence to a silver standard in a 20th century world had long been bemoaned as a symptom of her political and economic woes and a throwback to a bygone world once drained in Spanish American silver. Furthermore the Chinese silver regime defies easy classification in that its silver basis was not in coinage, but in the form of the horseshoe shaped ingots called *sycee* denoted by a unit of account called *tael*. Sycee were minted privately, varying in shape, weight or fineness from city to city. Sycee circulated alongside other media of exchanges such as Spanish, Mexican and later other Chinese silver dollars at the same time copper cash—the only small denomination currency coined by the Imperial government—remained the dominant media for small transactions.

[1] The Warlord Era was a period when the control of China was divided among its military cliques, with no central government having effective control over the whole country (Waldron, 2003).

Apart from a couple of recent studies that either focus on the world silver standard in general or China's external silver exchange (Fernholz, Mitchener, and Weidenmier, 2017, Jacks, Yan, and Zhao, 2017), we know relatively little about the operation of silver exchange and monetary regime within China. This is in sharp contrast to the large literature on the operation of the gold standard during the 19th–20th centuries, especially on the degree of efficiency through currency exchange arbitrage.[2] Our paper presents an in-depth analysis of China's unique silver regime and offers the first systematic econometric assessment of the Chinese silver market integration during 1898-1933. We compile a large data set culled from newspapers, professional journal publications and governmental reports on exchange rates between silver dollar and tael across eighteen cities in Northern and Central China. Our core data sets consist of monthly exchange rate data between Shanghai and Tianjin in 1898–1933 and daily rates of eighteen cities during the 1920s and 1930s. Drawing from the mechanism of gold point arbitrage, we formalize the theory of silver point arbitrage in the presence of transaction costs across spatial markets within China and offer a threshold time series methodology for measuring silver integration comparable to that on gold points (Canjels et al., 2004). We test our findings against data on actual quantities of silver flows and shipping costs during the 1920s.

Our econometric results point to a sharp improvement in monetary integration from the 1910s, precisely during the Warlord Era of national disintegration and civil strife. These achievements have allowed Republican China to catch up with the advanced gold-standard countries in terms of efficiency. We offer a historical analysis on the causes behind monetary integration at a time of political disintegration, attributing a central role to China's banking and financial revolution during this period engineered through a combination of Chinese and

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[2] Key contributions on the tests of the efficiency of the gold standard include, for instance, Morgenstern (1959), Clark (1984), Canjels, Prakesh-Canjels, and Taylor (2004), Flandreau (2004), Officer (2007), and Nogues-Marco (2013), etc.

Western commercial elites based in China's treaty ports. In this regard, our study on China's modern evolution also reveals new insights on the limits of China's traditional monetary and financial development, an issue neglected in the ongoing Great Divergence debate (Pomeranz, 2000, Brandt et al., 2014).

The rest of the article is organized as follows. We introduce the monetary system in China in the 19th–20th century in Section 2. Section 3 presents our econometric results of the currency market integration using the monthly frequency data for Shanghai and Tianjin in 1898–1933 and daily data for eighteen cities for the 1920s and 1930s. Section 4 provides robustness checks on our silver points based on the quantity and cost data of silver flows. Section 5 provides a historical narrative behind the money market integration. The last section concludes.

2. Silver currencies and silver exchange in China

2.1 Silver currencies in China

As the basis of the Chinese monetary system until the 1935 fiat currency reform, silver served as the denomination currency for China's international and interregional trade and as the unit of account and reserves for paper notes and interbank accounts for traditional and modern Chinese banks (Lin, 1936, p. 5). Sycee, the most important traditional silver currency usually weighed around 50 taels each. Although rarely used in daily transactions, sycee were the principal medium for wholesale transactions and tax payment such as land tax and customs duties (Fetter and Bratter, 1936). They were not produced by a central authority, but minted by private smelting firm called *Lufang* with its imprint stamped on every shoe of sycee it produced. The local silversmiths' guilds (*Gong-gu ju*) acted as public assayers to inspect the sycee and certify their fineness and weight. The sphere of circulation of any particular kind of sycee was usually confined to a local trading area. As they varied in fineness, shape, and weight, sycee had to be constantly assessed in exchange, often melted down and re-cast to conform to local standards whenever they circulated outside their local area.

The second physical form of silver currency in China was standardized silver coins (or dollars), first introduced to China from Spanish America during the early 16th century. The so-called Carolus dollars had become the most popular coins in China followed by the Mexican dollars (or the eagle dollars) after the collapse of the Spanish empire in South America and founding of the new independent Republic of Mexico. In the course of centuries other dollars made their appearance, but none have enjoyed the prestige and popularity of eagle dollar in China (Shiroyama, 2008, p. 19). It was estimated that the total amount of the eagle dollar circulating in China in 1911 was 500 million, accounting for far more than half of the total silver dollars circulating in China at that time (Kann, 1927, p. 145).[3]

In 1889, the southeast province of Guangdong struck China's first silver coin, the dragon dollar. In the next ten years, other provinces also established mints which began to proliferate. All dragon dollars were modeled after the eagle dollar but the lack of uniformity hampered its appeal and diffusion. The number of dragon dollars was estimated to be only 100 million as of February 1918, less than 10% of the total silver dollar stocks in China at that time (People's Bank of China, 1960, p. 164). The founding of the new Republic brought the introduction of the national dollar (also known as the Yuan Shih-kai dollar, bearing the image of the then president) in 1914. To facilitate the introduction, the Government arranged for the Bank of China, the Bank of Communications and the official provincial banks to exchange, free of charge, the old dragon dollars to the new national dollars. The uniformity and reliability of the national dollar made it into an unparalleled success, quickly driving out various dragon dollars, eventually eagle and other

[3] As an example, salt revenue (the second largest government revenue after maritime custom revenues), railway fares, and postage telegram fees were officially prescribed in the eagle dollar (People's Bank of China, 1960, p. 570).

foreign dollars. According to a survey in 1924, out of the 960 million silver dollars in circulation, 750 million were the national dollars (Kuroda, 2005, p. 114).[4]

Until its official abolition in the 1933 currency reform, sycee had been in concurrent circulation with silver dollars in most of the commercial places. Generally speaking, sycee was more used for account clearings within financial institutions and wholesale trade, and silver dollars more for daily circulation nationwide. The need for a common unit of account within the mixtures of silver currencies led to existence of various imaginary or bookkeeping tael units for different trading zones in China. Though bearing no equivalence to any actual currencies circulated in the market, these taels served as common units of account for the amalgam of currencies in circulation. Likewise, the silver contents of these abstract tael units also varied from city to city depending upon local custom (Fetter and Bratter, 1936). Among them, the Shanghai tael was the most well-known, being quoted in foreign exchange market and recognized by the Shanghai Foreign Exchange Bankers Association. The silver content of the Shanghai tael was 518.512 troy grains (or 1.0802 ounces) of pure silver (Young, 1931; Leavens, 1936). After the Shanghai tael, other widely used local taels were the Tianjin tael, the Hankow tael, etc., whose weight ranges approximately from 500 to 550 grains. In Table 1, we summarize the silver contents of several most important units of taels and silvers dollars.

Insert Table 1

2.2 Yangli in Shanghai and Tianjin 1898–1933

The most important indicator of China's silver currency market, called in Chinese (and hereafter referred to as) *yangli* (洋厘), is the dollar-tael exchange rate, that is, the actual market price of silver dollars expressed by their respective abstract

[4] A number of other dollars with different designs, but with weight and fineness equal to those of the Yuan Shih-kai dollar, had been issued under the Republic. The only ones quantities were the Sun Yat-sen dollars (Fetter and Bratter, 1936).

tael units,. It is important to note that yangli could deviate from its parity rate as shown in Table 1 to reflect the changing market demand for silver dollars in China. We now illustrate the long term trend in yangli using the case of Shanghai and Tianjin, the two most important financial centers in Central and Northern China.

Traditionally, China's silver exchange was largely in the hands of native banks, with the yangli rates monitored and set at the meetings of representatives of the native banks, held daily in the morning and early afternoon, in accordance with actual demand and supply conditions (People's Bank of China, 1960, p. 554). In Tianjin, there had always been only one unified exchange market for dragon, eagle and national dollars throughout (Jin, 1925, p. 233).[5] In contrast, before August 1915, there existed in Shanghai two separate dollar exchange markets for the eagle dollar and dragon dollar (against Shanghai tael) respectively. After August 1915, the dragon dollar market was replaced by national dollar market in Shanghai. Further, by May 1919, the eagle dollar market was closed down, leaving the national dollar as the sole currency quoted in Shanghai dollar-tael market (People's Bank of China, 1960, p. 573). Whichever types, the silver contents of dragon and national dollars approximated that of eagle dollars as revealed in Table 1.

We have collected the monthly observations of Shanghai and Tianjin yangli, which were the average of trading days in the respective month for the period from January 1898 to March 1933, with a total of 423 observations.[6] We denote Tianjin

[5] See also "The popular currencies in Tianjin and their exchange" (*Banker's Weekly*, 1917, 1(13), pp. 19–23). The principal dragon dollar circulated in Tianjin was the Beiyang dollar, which accurately resembled the eagle dollar. According to an assay made by the Chinese Central Mint at Tianjin, the pure silver content of the Beiyang dollar was 0.19% higher than that of the eagle dollar. In addition, the difference between the pure silver contents of varieties of dragon dollars (minted in major provincial mints, such as the Beiyang, Guangdong, Hubei, and Jiangnan Mints) were limited to within one per cent (Zhang, 2013, pp: 49–56).

[6] The sample period begins with 01/1898 because the data in Tianjin began its successive records only from that month. It ends in March 1933 as the dollar/tael exchange markets were closed off by the abolishment of the sycee and tael system and thus a single silver dollar standard was officially established in China. The yangli data in Shanghai are those for the eagle dollar before August 1915, and for the national dollar afterward.

and Shanghai yangli at time t with their respective tales as $y_{T,t}$ and $y_{S,t}$, and the parity ratio of Tianjin/Shanghai tales as $E_{T,S}$ (equal to 1.0551 as seen in Table 1).[7] We multiply the Tianjin yangli series with $E_{T,S}$ to place both yangli series on the common unit of Shanghai tales. Figure 1 (upper panel) plots the Shanghai and Tianjin series, i.e., $y_{S,t}$ and $y_{T,t}E_{T,S}$, in the form of deviation (in percent) of silver dollars from their parity values.

Insert Figure 1

In general, Figure 1 shows positive deviation from parity in both cities, indicating silver dollar was valued higher than its metallic contents, a premium associated with the convenience of a "countable" coin.[8] Overall, the yangli rates fluctuated widely over time and were sensitive indicators of comprehensive political and economic factors as well as consumer confidence in the money market in China. Prominent political events such as the Boxer Rebellion fiasco around 1900 and the fall of Qing Empire in late 1911 led to sharp surge in yangli. There are also notable drops as well such as 1932 reflecting the draining of silver from China's crisis stricken rural sector to cities due to the stagnation in agricultural commodity export during the Great Depression. Interestingly, it is one of the few occasions where yangli dipped substantially below parity. Besides the common global, national or regional forces impacting the yangli rates, there is a seasonal component in the yangli series related to agricultural harvests as vast majorities of dollars were transferred to facilitate agricultural trade in China. It has long been observed that May corresponded to the peak season of cocoon and tea purchase in China's central and southern regions where as October and November would correspond to the harvest season of cotton in northern China and rice in

[7] There is also market rate of exchange for Tianjin/Shanghai taels, which could deviate on a daily basis from their parity ratios of 1.0551 in Table 1. It is traded actively in the so-called domestic exchange （内汇）but only limited to major cities such Shanghai, Tianjin and Hankou. However, the deviation of their market rates from parity rates was too small to make any difference for our statistical analysis. In this paper, we simply used the parity rate throughout.

[8] The average of deviation from parity for yangli in Shanghai and Tianjin are 1.49% and 1.96% respectively, higher than the minting cost of national dollar, which is 0.926% (National Dollar Regulations, *State Council Bulletin*, no. 631 (1914)).

Central China (Yang, 1936, pp. 208–213; Ma, 2008). We will pick up on the seasonality issue later in the paper.

China's silver currencies moved across space conducted through the equivalent of a bills of exchange system. For example, to make a purchase in Tianjin, a Shanghai merchant could draw a bill of exchange with his native bank in Shanghai and sell (discount) the bill for cash or a Tianjin native bank order (analogous to cash cheques issued by modern banks) in Tianjin. In return, the Tianjin native bank could sell this bill to a Tianjin merchant who wants to make purchase in Shanghai. That is, for a Shanghai merchant to remit dollars to Tianjin, he needs first to exchange Shanghai taels with silver dollars, then exchanges the Shanghai tael to Tainjin tael to finally to obtain silver dollars from banks in Tianjin. With extensive branches or agents in other cities, Shanghai native banks played the leading role nationwide. Shanghai bill, called *Shenpiao* (申票) denominated in Shanghai taels has become the most accepted means of exchange instrument throughout the whole country (Wu L., 1935). As a contemporary observed, "Shanghai bill functioned, in a sense, as a national currency used popularly in domestic trade between the major commercial ports" (People's Bank of China, 1989, p. 185). During the 1920s and 1930s, the use of cable order as instrument of transfer became dominant as it spared the transport delay in the case of bills of exchange (People's Bank of China, 1960, p.184).

If the strong form of the law of one price holds, then the prices of silver dollar measured in Shanghai taels should be the same in both markets, that is, $y_{S,t} = y_{T,t}E_{T,S}$. We can also express this as the yangli spread (in percent) by $x_t = 100\ln(y_{T,t}E_{T,S}/y_{S,t})$ being equal to zero under the law of one price. Given frictions in the form of information and trade costs, one might naturally expect deviations from the law of one price. The lower panel of Figure 1 displays the monthly series for x_t. Here, a positive value of x_t suggests that the dollar is relatively overvalued in Tianjin market while a negative value of x_t suggests that the dollar is relatively undervalued in Tianjin. A contemporary economist described silver arbitrage mechanism, "Under normal conditions, the yangli will always hover around parity. If it is higher in Tianjin, silver coins in Shanghai will flow into Tianjin to make slight profits" (Wu S., 1935).

Figure 2 plots the standard deviation of x_t, which reveals a sharp decline in the 1910s. Using January 1912 as the breakpoint, Qing and the Republic sub-periods accounts for about 40 and 60 percent of the full observations, respectively. While the average of x_t during the entire sample is 0.47% with a standard deviation of 1.31%, the average in the first sub-period is 0.76% (with a standard deviation of 1.81%) but shrinks dramatically to only 0.29% in the second sub-period (with a standard deviation of 0.77%). To confirm this structural break without imposing a prior knowledge of the locations of breaks, we adopt endogenous breakpoint tests and employ the sequential testing procedure developed by Bai and Perron (1998) on the 60-month moving window standard deviation series of x_t. The sequential test results confirm one endogenous break of October 1913, which is slightly later than, but very close to, the date of political regime change.[9]

Insert Figure 2

For purpose of comparison, Figure 2 also plots the standard deviation of the Shanghai tael-US dollar exchange rate (deviation from mint parity), which is a good measure of Shanghai's linkage with the global market.[10] It shows that while World War I wreaked havoc on Shanghai-New York foreign exchange market, the same period marked a rapid and sustained decline in the standard deviations in

[9] We also calculate the standard deviation of x_t in 36-month or 48-month moving window. The results are quite close to that from 60-month moving window. Specifically, the corresponding break date is April 1913 for the series in a 36-month moving window, and February 1913 for the series in a 48-month moving window.

[10] As a silver-standard country, China was obliged to derive the parity value of its nominal exchange rate from the price of silver in New York commodity markets. Unlike the parity of two gold currencies, the parity exchange rate is not constant in the case of the Chinese silver standard.

the domestic exchange market in China. In other words, it seems that improvement in Chinese money market integration and efficiency gained momentum precisely at a time when the rest of the world was engulfed in turmoil.

3. Measuring integration in silver exchange market

3.1 The threshold autoregressive model for silver arbitrage

As the process of silver arbitrage in spatial markets incurs costs, the shipment of silver is thought to only occur if the inherent price of silver dollar in one port is above (or below) that in the other port by a sufficient margin. In other words, one price would not prevail simultaneously in every market at all times as differences within the bounds of the 'silver point' would remain. Silver points are hence described by the shipping cost of dollars. As Kann (1927, p. 172) noted, "The cost of making remittances through banks in China from one place to another ought not to exceed the cost of actually shipping the coins. Otherwise, the debtor port will ship coins instead of making remittances."

We now adopt a threshold autoregressive (TAR) methodology to estimate the relevant threshold for silver arbitrage activity. We refer to these estimated thresholds as silver points in direct parallel to the literature on gold points. Consider silver dollar's shipment across Shanghai and Tianjin. If the current yangli spread is above the silver point, exploitable arbitrage opportunities emerge and silver's flow into Tianjin will occur, leading to a reversion of the yangli spread. Thus, we postulate the following difference equation:[11]

$$\Delta x_t = k - \lambda(x_{t-1} - \theta) + v_t, \quad \text{if } x_{t-1} > \theta \tag{1}$$

where Δx_t is the first difference of x_t, the yangli spread, k is a constant, and v_t is an exogenous disturbance term and is assumed to be serially uncorrelated. Eq. (1) constitutes the error correction mechanism (ECM) for yangli spread. The

[11] See Canjels et al. (2004) and Jacks et al. (2017).

dynamics of yangli spread differ across regimes delineated by the position of a lagged value relative to given thresholds. If the contemporaneous spread is beyond the threshold θ, then silver arbitrage will push it toward θ at a speed of convergence defined by λ, that is, the spread will be fractionally reduced by λ in one period.

The case of silver outflows from Tianjin is analogous to that above:

$$\Delta x_t = k - \lambda(x_{t-1} + \theta) + v_t, \quad \text{if } x_{t-1} < -\theta \tag{2}$$

When the spread is less than $-\theta$ silver will be shipped from Tianjin and the spread will revert toward $-\theta$. Finally, when $|x_{t-1}| \leq \theta$, the spread is not large enough to overcome the costs of arbitrage, so there are no shipments for arbitrage purpose and the change in the spread follows a white noise process. The above three cases can be combined as:

$$\Delta x_t = \begin{cases} k - \lambda(x_{t-1} - \theta) + v_t, & x_{t-1} > \theta \\ v_t, & |x_{t-1}| \leq \theta \\ -k - \lambda(x_{t-1} + \theta) + v_t, & x_{t-1} < -\theta \end{cases} \tag{3}$$

This incorporates a simple formulation of the relevant silver points. If the contemporaneous spread is in outer regimes, then it will revert toward the edge of the band. In the middle regime, the yangli spread will not demonstrate any tendency towards convergence, with the process of x_t following a random walk within the "neutral band" of the silver points.

Eq. (3) is a special case of a TAR model. A general form of a 3-regime TAR model can be expressed as:

$$x_t = \begin{cases} \beta_0^u + \sum_{i=1}^{n} \beta_i^u x_{t-i} + \varepsilon_t, & x_{t-1} > \theta \\ \beta_0^m + \sum_{i=1}^{n} \beta_i^m x_{t-i} + \varepsilon_t, & |x_{t-1}| \leq \theta \\ \beta_0^l + \sum_{i=1}^{n} \beta_i^l x_{t-i} + \varepsilon_t, & x_{t-1} < -\theta \end{cases} \tag{4}$$

where ε_t is an exogenous disturbance term. In this model AR(n) dynamics obtain in each regime.[12] The process switches between three AR linear mechanisms

[12] If we restrict $n = 1$, $\beta_1^u = \beta_1^l$, $\beta_i^m = 1$, and some appropriate constrains on constants, Eq. (4) is reduced to Eq. (3).

dependent on the position of the lagged value of the process. Here, convergence to the edge of the band is allowed to be asymmetric. That is, the speed of convergence is defined by $\lambda^u = 1 - \sum_{i=1}^{n} \beta_i^u$ in the upper regime and $\lambda^l = 1 - \sum_{i=1}^{n} \beta_i^l$ in the lower regime. In addition, yangli spread is no longer restricted to follow a random walk process in the middle regime.[13] All our threshold models will be estimated using conditional least squares (CLS) estimators (see, for instance, Chan, 1993).

3.2 Monthly data for Shanghai and Tianjin, 1898–1933

We first estimate the restricted model as in Eq. (3) on our Shanghai-Tianjin yangli spread, using the full sample period from 1898–1933.[14] We restrict the grid search to values such that the upper and lower regimes combined have at least 10%, and at most 90% of the observations. The results are presented in Table 2. The threshold is estimated to be θ = 2.11%. The 90% asymptotic confidence intervals of θ, computed using Hansen's (1997) likelihood ratio methodology, is [1.90%, 2.33%]. To acknowledge the dramatic changes in the yangli spread series in the 1910s as shown in Figures 1 and 2, we also estimate Eq. (3) using January 1912 as the break date for two sub-periods. The results, also presented in Table 2, indeed show dramatic changes in both the thresholds and the speed of convergence in two sub-periods. The silver point is estimated to be 2.18% in the Qing Empire era before 1912 but reduces substantially to 0.63% in the Republican era, shrinking by 70 percent. The estimates of the speed of convergence, went from zero in the first sub-period to 0.43 in the second. That is, the outer-regime convergence toward the thresholds is valid only for the second sub-period but not for the first. The changes in both threshold and speed of convergence strongly point to increasing market integration from the 1910s.

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[13] Once the effect of speculation is considered, x_t in the middle regime within the silver point band can still be characterized as a stationary process. See the analogous mechanism on the gold standard in Officer (1989).

[14] All commonly used methods for testing linear versus nonlinear models that appear in the literature—including the LST (Luukkonen, Saikkonen, and Teräsvirta) test, the Tsay test and the Chan modified likelihood ratio test (Chan, 1991)—strongly reject linearity for yangli spread, with *p*-values less than 0.01, suggesting that a threshold model is more appropriate than a linear AR model in modeling the dynamics of the series.

Insert Table 2

We use Chan's test for testing additional nonlinearities in the residual series (Cryer and Chan, 2008, p. 401).[15] The Chan statistics are reported in Table 2, suggesting that remaining nonlinearities are somewhat problematic for the model as applied for both the full period and the second sub-period. In addition, for the entire period and each sub-period, the residual series are clearly not uncorrelated over time, as reflected by the highly significant Ljung-Box Q test statistics. We suppose that the problems might be caused by strict constraints in Eq. (3), such as a single lag in AR processes, the unit root in middle regime or symmetry in speed of convergence.

We now proceed to estimate using general model as in Eq. (4). This allows for higher-order AR processes, nonrandom walk behavior in inner band and the asymmetry of convergence coefficient. To discriminate between models with different values of n, we choose n = 3 or 2 as these serve to minimize the values of the Schwarz information criterion (BIC). Table 3 shows both the results from the entire period and sub-periods. For the full period, the general model have a silver point substantially lower than that from the restricted model. But for each sub-period, there is no material change in the silver point estimates using either the restricted model or the general model. In particular, both models confirm a significant decline in the silver points after the 1910s. Compared to the earlier results, the Chan statistics are now much lower and insignificant, suggesting that there is little remaining nonlinearity. In addition, each residual series is uncorrelated over time. We view these results as offering some support for the general TAR model. However, unit root in the middle regime and convergence towards the silver points in the outcome regimes are currently borne out in our

[15] Here, the null hypothesis is an AR model versus the alternative hypothesis of a two-regime TAR model with constant noise variance. It should be noted that the sampling distribution of the likelihood ratio test under the null hypothesis is no longer approximately χ^2. Instead, it has a nonstandard sampling distribution (Chan, 1991).

estimates for the first sub-period sample but not for the second sub-period and the entire period. Moreover, for the first sub-period, yangli spread exhibit explosive behavior in the lower regime. As we shall see later, the problem is caused—at least partially—by our low-frequency (monthly) data here.

Insert Table 3

Of the 423 monthly observations, the upper regime accounts for 75 observations. Silver shipments from Shanghai to Tianjin were, therefore, profitable in these months. The lower regime accounts for 32 observations where silver shipments in the opposite direction were profitable. This reveals that silver dollar was overvalued much more often in Tianjin than in Shanghai. This is consistent with the fact that Shanghai is the initial entry for silver imports from America and elsewhere and then transshipped elsewhere in China (Kann, 1927, p. 100).

We now further test the possibility that the change in silver points occurred gradually over time, rather than instantaneously from the old to the new regimes, by using a moving window method to estimate the changes of thresholds. Taking a moving window of 120 observations (10 years), we estimate the silver point in each window. The window is shifted by 12 observations each time to limit the computational burden, that is, we re-estimate the restricted model and the general model using the sub-periods of 1/1898–12/1907, 1/1899–12/1908, etc. Figure 3 reveals that the silver points drop steadily in the 1910s, rather than decline gradually over the entire period. Thus, the turning point is much likely to be somewhere in the mid-1910s, which is roughly consistent with the result of endogenous breakpoint tests on the yangli spread series. Clearly, a rapid improvement in market integration occurred in the 1910s.

Insert Figure 3

3.3 Daily data for eighteen cities in the 1920s and 1930s

We now turn to a new yangli data set with daily frequency, which allows us to capture the high-frequency dynamics likely obscured by the monthly data. Our daily data extends our geographic coverage to a total of eighteen cities including Shanghai and Tianjin but only for the period of the 1920s and early 1930s.

We first examine the relationship of daily yangli data for Shanghai, Tianjin and Hankou for the 1920s. Hankou, known today as Wuhan in Hubei province, ranked after Shanghai and Tianjin as the most important financial center in the heartland of China. We have to discard the Hankou data after 1927 due to the serious war disruption by the Nationalists led Northern Expedition and the subsequent decree of banning silver outflow issued by the government there. We have at our disposal a total of 2593 and 1356 daily yangli observations for the estimation of Shanghai-Tianjin and Shanghai-Hankou markets, respectively for the periods of 1/1921–12/1929 and 1/1923–7/1930.[16] Analogously, we denote the yangli spread between Hankou and Shanghai as $x_t' = 100\ln(y_{H,t}E_{H,S}/y_{S,t})$, where $y_{H,t}$ the yangli in Hankou at time t, and $E_{H,S}$ is the parity exchange rate of Hankou tael against Shanghai tael (see Table 1).

We estimate the TAR model as in Eq. (4) for the two pairs of cities and report the results in Table 4.[17] The estimate of the silver point for the Shanghai-Tianjin markets is 0.94%, substantially larger than the corresponding result (0.63%) generated from the monthly data for the second sub-period using the TAR model. This higher threshold value in the daily data reveals that the monthly data to

[16] The radical left wing of the Kuomintang and the Communists occupied Hankou by force and issued the decree of a total embargo on silver on April 17, 1927. In light of this decree, only notes issued by a few government banks were allowed to circulate, with the circulation and outflow of specie from Hankou strictly prohibited (*North-China Herald*, 19 April 1927, p. 11). Silver currency hold by private sector were forced to be exchanged for bank notes. In imposing the decree, Hankou had effectively divorced itself from a pure silver standard. Therefore, it is naturally to expect that sharp volatility in Hankou yangli was not being met with silver shipments.

[17] We also estimate the restricted model as in Eq. (3) using daily data. There is no material change in the results on silver points. For simplicity, only the results from the general TAR models are reported.

some extent obscured or 'smoothed' the high-frequency volatility. The results from daily data confirm the validity of the outer-regime convergence toward the thresholds and the random walk process in the middle regime. Specifically, the speed of convergence is estimated to be around 0.15 in the two outer regimes. That is, deviations greater (in absolute value) than the estimated silver point will be, reduced by 15 percent within a trading day, or equivalently, that the half-life of such spreads is four trading days in the outer regime. In contrast, the middle regime barely shows any convergence, with a speed at a mere 3.2 percent, giving rise to a root very close to unit. The middle regime is estimated to encompass over 85% of the observations, implying that the yangli in Shanghai and Tianjin seldom strayed from each other even in the context of daily frequency data. The upper and lower regimes encompass 8% and 7% of the observations, respectively. Thus, we find remarkable symmetry in both the speed of adjustment and the number of observations underling the two outer regimes.

Insert Table 4

The estimate of the silver points for the Shanghai-Hankou markets is 0.85%, slightly smaller than the estimates of silver points for Shanghai-Tianjin market. This is consistent with the fact that Hankou is well-connected with Shanghai by the Yangzi River with a linear distance of only 750 against the 1000 kilometers distance between Tianjin and Shanghai. The estimates of convergence speed also matches well with the findings of the silver point arbitrage model, That is, the outer regimes shows fast convergence and the middle regime has a root much closer to unity. The mean convergence rates toward the thresholds is around 0.2 (or with a half-life of three days) in the two outer regimes. It was again a more frequent occurrence that dollar was overvalued in the Hankou market relative to the Shanghai market. This is a result consistent with Hankou's previously noted net inflow of silver dollar.

We now turn to the second set of daily data for a total of eighteen cities for the brief period of 1921–23 and 1930–31. Other than Shanghai, Tianjin and Hankou, there are six cities in Zhejiang province which are (sample period reported in parentheses): Hangzhou (1/1921–1/1923; 7/1930–12/1931), Huzhou (1/1921–12/1922), Jiashan (1/1921–12/1922), Jiaxing (1/1921–12/1922), Ningbo (1/1921–12/1922), Xiashi (1/1921–12/1922); four cities in Jiangsu province: Suzhou (1/1921–1/1923), Xuzhou (7/11/1930–4/10/1931), Yangzhou (7/1930–12/1931), Zhenjiang (1/1921–11/1921; 7/1931–12/1931); one in Anhui province: Wuhu (10/1930–12/1931); two in Jiangxi province: Jiujiang (7/1930–12/1931), Nanchang (7/1930–12/1931); and two in Shandong province: Jinan (9/1930–12/1931) and Qingdao (7/1930–12/1931).

We use an analogous TAR model as in Eq. (4) to estimate the silver points between Shanghai and each of these cities. Figure 4 makes a simple linear plot between the estimated silver points of these cities (paired with Shanghai) and the linear distance (from Shanghai). To more fully capture the determinants of the magnitude of the silver points, we run the following regression:

$$\theta_i = c_0 + c_1 Dis_i + c_2 d_{BE,i} + c_3 d_{BE,i} * Dis_i + c_4 d_{rail,i} + c_5 d_{tras,i} + \varepsilon_i \quad (5)$$

where i denotes a city. The dependent variable θ_i is the silver point between Shanghai and city i; Dis_i is the corresponding linear distance (unit: 100 kms); $d_{BE,i}$ is an indicator variable which takes the value of 1 for the 1921–23 period (in the Warlord Era) and 0 for the 1930–31 (in the Nanjing Decade). The interaction term $d_{BE,i} * Dis_i$ captures the difference in the slope coefficient of Dis_i between the two periods. $d_{rail,i}$ is an indictor variable representing that city i is connected to Shanghai by railway. $d_{tras,i}$ is an indictor representing that city i is not connected to Shanghai by any major transport such as railroads, sea or the Yangtze River routes. ε_i is a random error.

Insert Figure 4

The results of Eq. (5) are presented in Table 5. We arrive at a significant and positive coefficient of Dis, which means every increase of distance of 100 kilometers from Shanghai increases the silver points by about 0.06%. The positive coefficient of d_{tras} reveals for cities not connected by major water or rail transport would see their silver point raised by an additional 0.31%. Both the insignificant coefficients of d_{BE} and $Dis * d_{BE}$ indicating no major improvements in money market integration in the Nanjing Decade than the Beiyang Era. If anything, these improvements have occurred in the 1910s. We show this more dramatically by inserting in figure 4 the 1898–1911 Shanghai-Tianjin silver point estimate (derived from Table 3), which stood at 2.18% compared with the 0.94% figure for the 1921-29 period (from Table 4).

Insert Table 5

4. Robustness: silver points, shipping costs and silver flows

4.1 Silver points and silver flows

So far, all our tests on money market integration are inferred through the indirect observation based on the price dynamics of yangli. We have compiled a dataset on actual silver flows, which allow us specifically test whether yangli spread and our estimated silver points help predict corresponding transaction volumes. Our dataset are weekly records on the actual volume of silver dollar shipments from Shanghai to Tianjin/Hankou, and silver dollar arrivals to Shanghai from Tianjin/Hankou, for the period of 1922–30, taken from the *North-China Herald* in its Weekly Exchange Notes column (reported on every Friday). The weekly frequency nature of our silver flow data does not perfectly match the nine and six days shipping time between Shanghai and Tianjin and Hankou markets respectively. In Figures 5 and 6, we made adjustment by using the maximum of the yangli spread in the three days before the actual shipment from Shanghai, or the minimum of the yangli spread in the ten (seven) days before the actual arrival to Shanghai from Tianjin (Hankou). In these figures we also plot our silver point estimated from the TAR models using daily data. On the bottom of these figures we show the actual volume of silver dollar movement.

Insert Figures 5 and 6

A visual inspection of the figures reveals a general correspondence between the magnitude of the yangli spread exceeding the silver points and the actual flows of the silver dollars between the pair of cities. Almost all of the large exports from Shanghai occurred when yangli spread were above the estimated thresholds and only limited flows when the spread fell within the bounds of the silver points. Figures 5 and 6 also reveal other factors accounting for the silver moments. Agricultural seasonality for Shanghai and Tianjin (usually late autumn and early winter) is one relatively independent factor. Another factor is major disruptions such as the Jiangsu-Zhejiang War (September and October of 1924) and Northern Expedition (1927-28) caused major disruptions in silver exchanges despite the existence of arbitrage opportunities.[18]

We now formally test our insights from Figures 5 and 6 by estimating a Probit model. In this model, the dependent variable is a dummy which equals to one when there is an occurrence of silver flows between the pair of cities. The key explanatory variable (d_{ys}) is a dummy variable which equals to one when the instance of the yangli spread exceeds our preferred silver point estimate (that is, >0.94% or <−0.94% for the Shanghai-Tianjin markets, and >0.85% or <−0.85% for the Shanghai-Hankou markets). Additional controls include dummy variables for the period for the Jiangsu-Zhejiang War, and the Northern Expedition for the

[18] Here, one report help to recognize the effects of war: "Immediately after the outbreak of hostilities between the Jiangsu and Zhejiang provinces, the Shanghai-Nanjing railway was closed to civilian traffic in September 2. The *Henli* railway bridge was torn down by Jiangsu forces and the railway bridge between Anting and Lujiangbang was wrecked by Zhejiang forces. Above Nanxiang telegraph and telephone communications were halted early in the morning." (*Chung Hwa English Weekly*, Shanghai, 1924, 11 (275), p. 532).

Shanghai/Hankou trade, and for the months of October and November, to represent the peak agricultural harvest season in North China.[19] As shown in Table 6, we arrive at positive and highly significant coefficients on d_{ys} while coefficients of other control variables have the expected signs. For example, when silver flow from Shanghai to Tianjin, the coefficient of d_{ys} is estimated to be 0.61, implying the probability of the occurrence of silver flows when $d_{ys} = 1$ (the yangli spread exceeds the silver point) is about 4 times that when $d_{ys} = 0$ (the spread fell within the bounds of the silver points). Thus, the economic and statistical significance of this measure is substantial, leading to a measure of corroboration between the estimates of our model and independent volume flow data.[20]

Insert Table 6

4.2. Silver points and silver shipping costs

We now compare our silver point estimates to contemporary accounts of silver dollar movement costs, which are available for the 1920s. In the Tianjin-Shanghai silver trade, there were two principal routes: from Shanghai by direct steamer to Tianjin which entailed a cost of 0.76% (including freight and incidental expenses of 0.70% plus an insurance premium of 0.06%); or from Shanghai by the *Jinpu* (Tianjin-Nanjing) Railroad and *Huning* (Shanghai-Nanjing) Railroad *via* Nanjing which entailed a cost of 0.74% (Jin, 1925, pp. 19–21). Adding a nine-day annualized 5% cost would raise the total cost to 0.88% by direct steamer or 0.86% by railroad, respectively. Given the similar levels of transport costs, both systems were widely adopted in silver shipments across Shanghai and Tianjin in the 1920s (Feng, 1926). These contemporary accounts on silver shipping costs are close to or slightly lower than our silver point estimates of 0.94% for the Shanghai-Tianjin

[19] The Northern Expedition lasted longer, but our dummy only controls the period from January to December 1927 when Shanghai was affected.

[20] We also conduct a Tobit test with the dependent variable as the actual quantities of silver flows. The results are similar to our Probit estimation here.

markets in the 1920s (based on daily data in Table 4), which is quite reasonable as silver points estimates may well include a risk premium for the volatility of yangli.

Analogously, the silver point estimate for the Shanghai-Hankou markets also matches well with actual costs of the silver trade derived from contemporary accounts. The cost of shipping silver dollar from Shanghai to Hankou by steamer *via* the Yangzi River was 0.52%, adding a 6-day interest with an annualized 5% rate increased the total cost to 0.60% of the value shipped (Jin, 1925, p. 18). Also, our silver point estimate of 0.86 is only slightly higher than actual costs. Given this close correspondence, there were apparently no significant informational barriers to the silver trade within China in this period.

We can also make a comparison of our Shanghai-Tianjin silver point estimates with those between Shanghai and New York City at that time. There are three routes for the New York-Shanghai silver trade: from New York by direct steamer (or through bill of lading by steamer via San Francisco) which entailed a cost of 1.71%; or from New York *via* Seattle, Vancouver, or Victoria by rail which entailed a cost of 2.05%; or from New York via London which entailed a cost of 2.65% (Kann, 1927, p. 10). These costs are consistent with recent studies by Jacks et al. (2017) which show their silver point estimates across Shanghai and New York to be about 2.0% in the 1920s. Therefore, we can see both the silver point estimates and reported shipping costs of New York-Shanghai are consistently about two to three times those of the Shanghai-Tianjin figures.

Finally, we can make a comparison of our silver point estimates with the well-known estimates of the gold points under classical gold standard between London and New York City. Officer (2007), for instance, estimates gold points of 0.50% for the period of 1900–1913, while Canjels *et al.* (2004) estimate gold points of 0.67%

for the period of 1879–1913. Although not so different in magnitude, these pairs of estimates are not exactly comparable as they are for different periods, for different distance - Tianjin and Shanghai being far closer than that between London and New York - and different value to weight ratio with silver being much lower than gold. Despite that, once we match all the available silver points and shipping costs data coming from the three different comparison, it seems safe to say that by at least by the 1920s, domestic financial integration across China may have risen near the international standard in the advanced countries of the time.

5. Monetary integration and financial transformation

Our study has demonstrated the emphatic rise of a national monetary market from the late 19th century onward. In particular, it reveals surprising new insights on the 1910s—one of the most eventful decade in world and Chinese history—as the beginning of a major breakthrough in monetary and financial markets. Despite the outbreak of WWI on the international front and the collapse of Qing Empire within, the chaotic era of the Warlord Era also saw the full swing of China's first phase of modern economic growth marked by the surge of modern industries, trade, investment and finance. One driving force behind this surge was the visible improvements in transport infrastructure. Most notably, completed in 1912, the Tianjin-Nanjing Railway, joint with the Shanghai-Nanjing Railway and Shanghai-Hangzhou Railway constructed in 1908 and 1916 respectively, became a major artery linking China's North and South.[21] More important is the diffusion of new information and communication infrastructure such as telegraphs, postal services and etc. as vividly captured in the following newspaper report on August

[21] While important, the impact of railroad infrastructure may be limited given that silver shipping cost of rail transport across Shanghai and Tianjin was not substantially lower than the cost of sea transport throughout the period. Moreover, transportation improvements did not seem to lead to similar magnitude of market integration in grain markets during this period as we observe here for currency markets. Using the grain prices between Zhili province (where Tianjin is located in) and the Lower Yangzi areas (where Shanghai is located in) provided by Li (2000), we find the correlations of grain prices between Zhili and Lower Yangzi are 0.78 and 0.75 in the periods of 1900–1911 and 1912–1923, respectively.

26th 1932: "Yesterday morning, a certain native bank in Tianjin received a telegram that there was a surge in the price of silver dollar in Shanghai, this was immediately followed by a spike in silver dollar in Tianjin. But soon in the afternoon, another telegram arrived to inform that it was false information. Very quickly silver dollar market in Tianjin returned to the original state" (Morota, 2013).

Possibly, a second more consequential factor is the monetary and financial transformation marked by the rise of a modern banking system from the end of the 19th century. By 1911, China saw the establishment of important government banks such as Bank of China and Bank of Communication as well 17 private commercial banks (Cheng, 2003). Western treaty ports particularly Shanghai offered relative security and favorable property rights regimes conducive to the growth of modern Chinese banking particularly during the recurrent phases of national instability following the 1911 political regime change.[22] Most prominent is the rise of Shanghai which led to the growth of a largely autonomous banking sector spawned the rise of China's important banking associations, with the most important being the Chinese Bankers' Association (CBA) and the Native Bankers' Association (NBA) established in Shanghai 1915 and 1917 respectively. They coordinated collective action, established trading standards, publicized important financial statistics (much of which used in this study), lobbied governmental and other formal public institutions.

Both CBA and NBA defended the reputation and purity of China's national dollar.[23] It was CBA that coordinated with modern Chinese banks to close the

[22] For the importance of Shanghai International Settlement to modern Chinese banking, see the well-known dramatic bank note suspension incident in 1916 in an era of fiscal crisis during the Republican era (see Cheng, 2003, p. 59–62; Ho and Lai, 2013).

[23] A prominent example in this respect was the debasement incident in August 1925. When it was brought to light that many thousands of debased dollars were circulating in Shanghai, the CBA and NBA telegraphed to the Ministry of Finance in Beijing, the Jiangsu civil authorities and the Nanjing Mint (*North-China Herald*, 28 August 1925, p. 12). After an investigation order by the Jiangsu provincial governor, within one week the Shanghai constabulary discovered the mint and

exchange market for the dragon dollar and eagle dollar in 1915 and 1919 in Shanghai, respectively, and opted for a single national dollar exchange market. Overtime, the "countable" dollar outperformed "weighable" sycee as a medium of exchange, gaining an increasing share in China's monetary system. For instance, in the silver reserve of Shanghai banks, the ratio of silver dollars relative to silver ingots (sycee and bar silver) measured in value was 0.37 in 1918, but rose dramatically to 0.63, 0.88, 1.00 and 2.29 in 1921, 1925, 1928 and 1931, respectively (People's Bank of China, 1960, p. 584). This eventually paved the way for the currency reform of 1933 under the Nanjing Government, which abolished sycee and tael and retained dollar as the sole monetary standard. Thereafter, the National Government Central Mint began the coinage of a new national dollar.

Another monetary transformation is the increasing popularity of banknotes and deposits associated partly with the rapid growth of new financial instruments such as public debt.[24] The system of Chinese bank note issuance were largely run on a model of free banking with multiple public and private banks, Chinese or foreign, issuing silver-convertible banknotes based on reputation mechanism. Again, the Chinese banking communities initiated efforts to enhance the reputation of banknotes by publicizing statistics on bank reserves of note-issuing banks and establishing independent monitoring committees in 1928 as well as other institutional innovations (Yang, 1936, pp. 124–5, Ma, 2012). The substitution effect of banknote over silver specie became increasingly obvious as Feng (1926) observed that, "In recent years, banknotes are widely used in Inland and agricultural producing areas, as they are much easier to carry compared with

models of the debased dollars by a powerful government functionary (*China Press*, 16 September, p. 1). According to the request of CBA and NBA, the debased dollars were finally redeemed by the Jiangsu provincial authorities and destroyed.

[24] The rise of Chinese governmental bonds was closely connected with China Maritime Customs administered mostly by British staff (Van de Ven, 2014).The domestic banks were the largest bondholders, who held bonds both for investment and as a reserve to cover banknotes. China's banking regulations allowed banks to use governmental bonds—in the range of 40%—to serve as reserves for bank notes, with the rest in some form of species (Brand and Sargent, 1989).

silver dollars. Even in times of political unrest and economic turmoil, banknotes remain unblemished in creditability and convertibility."

Figure 7 reveals that while total species as measured by silver bullion, dollars and copper cash barely registered any increase during 1910–35, total money supply (M1) which includes species increased at an annual rate of 4.3%. This is only possible because the bank notes and deposit components of M1 surged at a remarkable annual rate of 9.5% during the same period. As a result, the estimated share of notes and deposits in M1 rose from 29 percent in 1910–15 to 47 percent in 1925 and 72 percent in 1935 (Rawski, 1989, p. 157). As observed in Figure 7, the turning point marked by an uptick in M1 around 1917–18 corresponds closely to the rise of Chinese modern banking.

Insert Figure 7

We can examine impact of bank notes on money supply by examining the seasonal patterns in banknotes issued and silver reserves of the banks in Shanghai for the period of 1928–36. As we can see in Figure 8, the pattern of seasonals in banknote issue and silver reserves are reverse, indicating bank's adjustment in note issues and reserve ratios to mitigate cyclical demand for cash. In Figure 8, we also insert the seasonal patterns in Shanghai yangli, calculated by regressing the Shanghai yangli on 12 seasonal dummies, with the monthly coefficients normalized to sum to 1 over twelve-month period. It shows that the quantitative patterns of bank note issues more or less track the peak and trough of yangli (high at various agricultural trade and squaring accounts demand at the end of the Chinese lunar year, respectively, and low in the summer).[25] Given that the 1910s marked the rise of modern banking, we are possibly observing that increasing note issue have provided a much more elastic currency to smooth the seasonality in money market

[25] The amplitude of the seasonal pattern in Shanghai yangli is approximately 0.8% of parity value. That is, yangli is approximately 0.4% higher than average in the fall and February and 0.4% lower than average in the summer. The seasonal patterns of the yangli in Hankou roughly corresponds with the Shanghai series.

and enhance market integration across Shanghai and Tianjin and beyond.[26]

Insert Figure 8

6. Summary

Based on the compilation of a high frequency monetary data and rigorous econometrics tests, our paper contributes new insights on Chinese monetary integration and economic performance in the late-Qing and Republican era and the workings of silver regimes in historical eras. We find that Chinese monetary and financial transformation took off from the 1910s, marched on during the 1920s and 1930s in spite of the disruptions by warfare and revolution at the regional or even national level. Indeed, the so-called Beiyan or Warlord era may have laid the foundation for the achievements of the new Nationalist regime during the Nanjing decade. We argue that it was domestic forces that drove the efficiency progress of China's silver regime to eventually rival the standards of the global monetary market. Indeed, it was China's move from sycee, imported silver dollars toward a single national silver dollars and eventually towards credible banknotes convertible to silver that became the hallmark of China's transformation in her own monetary standard. The prolific discussion in the literature on the choice of gold versus silver standards for China neglected this most critical elements of the internal monetary issues in China (for example, Brandt and Sargent, 1989; Friedman, 1992; Rawski, 1993; Shiroyama 2008).

More importantly, the monetary and financial transformation occurred in a context of institutional revolution largely championed by China's civil and commercial group in China's relatively rare period of political decentralization. It

[26] There has been a large literature on the change in the seasonality of monetary market in the gold countries. In 1914, following the creation of the Federal Reserve System, seasonals in nominal rates almost completely disappeared. Naturally, many authors argue that the reason is the Federal Reserve began to provide anti-seasonal monetary policy to smooth interest rates at that time (for example, Miron, 1986; Meltzer, 2003). Interestingly, we also find the amplitude of the seasonal patterns decreased dramatically outside the gold club at almost the same time.

gave rise to what we now today know as China's own golden age of bourgeoisies. It was ironic that monetary fragmentation that had actually prevailed under traditional China's highly centralized political regime was gradually overcome during China's early 20th century marked by political decentralization and disintegration. The autonomous treaty port of Shanghai in early 20th century may have replicated the central role played by financial hub cities such as Venice, Amsterdam or the City of London in early modern Western Europe. Hence, our study also hints at the central role of political institutions as a possible key to understanding the Great Divergence between Western Europe and China in the early modern era.

References

Bai, Jushan, and Pierre Perron. "Estimating and Testing Linear Models with Multiple Structural Changes." *Econometrica* 66, no. 1 (1998): 47–78.

Bordo, Michael D., and Hugh Rockoff. "The Gold Standard as a 'Good Housekeeping Seal of Approval'." *Journal of Economic History* 56, no. 2 (1996): 389–428.

Brandt, Loren, and Thomas J. Sargent. "Interpreting New Evidence about China and US Silver Purchases." *Journal of Monetary Economics* 23, no. 1 (1989): 31–51.

Brandt, Loren, Debin Ma, and Thomas G. Rawski. "From Divergence to Convergence: Reevaluating the History behind China's Economic Boom." *Journal of Economic Literature* 52, no. 1 (2014): 45–123.

Brandt, Loren. *Commercialization and Agricultural Development: Central and Eastern China, 1870–1937*. New York: Cambridge University Press, 1989.

Canjels, Eugene, Gauri Prakash-Canjels, and Alan M. Taylor. "Measuring Market Integration: Foreign Exchange Arbitrage and the Gold Standard, 1879–1913." *Review of Economics and Statistics* 86, no. 4 (2004): 868–882.

Chan, Kung Sik. "Consistency and Limiting Distribution of the Least Squares Estimator of a Threshold Autoregressive Model." *Annals of Statistics* 21, no. 3 (1993), 520–533.

Chan, Kung Sik. "Percentage Points of Likelihood Ratio Tests for Threshold Autoregression." *Journal of the Royal Statistical Society. Series B (Methodological)* 53, no. 3 (1991): 691–696.

Cheng, Linsun. *Banking in Modern China, Entrepreneurs, Professional Managers, and the Development of Chinese Banks, 1897–1937*. Cambridge: Cambridge University Press, 2003.

Clark, Truman A. "Violations of the Gold Points, 1890–1908." *Journal of Political Economy* 92, no. 5 (1984): 791–823.

Cryer, Jonathan D., and Kung-Sik Chan. *Time Series Analysis with Applications in R*. Springer Press, 2008.

Eichengreen, Barry J. *Globalizing Capital: A History of the International Monetary System*. Princeton, NJ: Princeton University Press, 2008.

Feng, Yangyuan. *Yangli yu yinchai zhi gainian* (The Concepts of Silver Dollar Exchange Rate and Lending Rate). *Yinhang zhoubao* (*Banker's Weekly*) 10, no. 29, August 3, 1926.

Fernholz, Ricardo T., Kris J. Mitchener, and Marc D. Weidenmier. "Pulling Up the Tarnished Anchor: The End of Silver as a Global Unit of Account." *Journal of International Money and Finance* 74, (2017): 209–228.

Fetter, Frank Whitson, and Herbert M. Bratter. "China and the Flow of Silver." *Geographical Review* 26, no. 1 (1936): 32–47.

Flandreau, Marc. *The Glitter of Gold: France, Bimetallism, and the Emergence of the International Gold Standard, 1848–1873*. Oxford: Oxford University Press, 2004.

Friedman, Milton. "Franklin D. Roosevelt, Silver, and China." *Journal of Political Economy* 100, no. 1 (1992): 62–83.

Ho, Tai-kuang, and Cheng-chung Lai. “Silver Fetters? The Rise and Fall of The Chinese Price Level 1928–34.” *Explorations in Economic History* 50, no. 3 (2013): 446–462.

Jacks David, Yan Se, and Zhao Liuyan. “Silver Points, Silver Flows, and the Measure of Chinese Financial Integration.” *Journal of International Economics* 108, (2017): 377–386.

Jin, Bangping. *Guonei shangye huidui yaolan* (A Survey on Domestic Commercial Exchanges). Shanghai: Shanghai Commercial and Savings Bank, 1925.

Kann, Eduard. *The Currencies of China: An Investigation of Silver & Gold Transactions Affecting China, with a Section on Copper*. Kelly & Walsh, 1927.

Kuroda, Akinobu. “The Collapse of the Chinese Imperial Monetary System.” In *Japan, China, and the Growth of the Asian International Economy, 1850–1949,* edited by Sugihara Kaoru, 103–127. Oxford University Press, 2005.

Li, Lillian. “Integration and Disintegration in North China's Grain Markets, 1738–1911.” *Journal of Economic History* 60, no. 3 (2000): 665–699.

Lin,We-Yin. *The New Monetary System of China: A Personal Interpretation*. Chicago: University of Chicago Press, 1935.

Ma, Debin. “Chinese Money and Monetary System, 1800–2000, Overview.” In *Handbook of Key Global Financial Markets, Institutions, and Infrastructure*, edited by Caprio Gerard, 57–64. Netherlands: Academic Press, 2012.

Ma, Debin. “The Rise of a Financial Revolution in Republican China in 1900–1937: An Institutional Narrative.” *LSE Economic History Working Paper Series* No. 235 (2016): http://www.lse.ac.uk/economicHistory/workingPapers/2016/WP235.pdf

Ma, Junya. “Traditional Finance and China's Agricultural Trade, 1920–1933.” *Modern China* 34, no. 3 (2008): 344–371.

Meissner, Christopher M. “A New World Order: Explaining the International Diffusion of the Gold Standard, 1870–1913.” *Journal of International Economics* 66, no. 2 (2005): 385–406.

Meltzer, Allan H. *A History of the Federal Reserve*. Chicago: University of Chicago Press, 2003.

Minami, R. and Makino, F. *Asian Historical Statistics: China*. Tokyo: Toyo Keiza Shinbumsha, 2014.

Miron, Jeffrey. “Financial Panics, the Seasonality of the Nominal Interest Rate, and the Founding of the Fed.” *American Economic Review* 76, no. 1 (1986): 125–140.

Mitchener, Kris J., Masato Shizume, and Marc D. Weidenmier. “Why Did Countries Adopt the Gold Standard? Lessons from Japan.” *Journal of Economic History* 70, no. 1 (2010): 27–56.

Morota, Hiroak, “Money Supply Mechanism and Financial Modernization in 1920-30 Tianjin”, Social Economic History Review 79, no. 3 (2013): 69–90.

Morgenstern, Oskar. *International Financial Transactions and Business Cycles* (Vol. 8). Princeton, NJ: Princeton University Press, 1959.

Nogues-Marco, Pilar. “Competing Bimetallic Ratios: Amsterdam, London, and Bullion Arbitrage in Mid-Eighteenth Century.” *Journal of Economic History* 73, no. 2 (2013): 445–476.

Officer, Lawrence H. "The Remarkable Efficiency of the Dollar-Sterling Gold Standard, 1890–1906." *Journal of Economic History* 49, no. 1 (1989): 1–41.

Officer, Lawrence H. *Between the Dollar-Sterling Gold Points: Exchange Rates, Parity and Market Behav*ior. Cambridge: Cambridge University Press, 2007.

People's Bank of China (Shanghai Branch). *Shanghai Qianzhuang Shiliao* (Historical Materials of Shanghai Native Banks). Shanghai: Shanghai Renmin Press, 1960.

Rawski, Thomas. "Milton Friedman, Silver, and China." *Journal of Political Economy* 101, no. 4 (1993): 755–758.

Rawski, Thomas. *Economic Growth in Prewar China*. Berkeley: University of California Press, 1989.

Shiroyama, Tomoko. *China during the Great Depression: Market, State, and the World Economy, 1929–1937*. Cambridge, MA: Harvard University Asia Center, 2008.

Shiue, Carol. "Transport Costs and the Geography of Arbitrage in Eighteenth-Century China." *American Economic Review* 92, no. 5 (2002): 1406–1419.

Stanfield, Brian, and Wolfgang Keller. "Markets in China and Europe on the Eve of the Industrial Revolution." *American Economic Review* 97, no. 4 (2007): 1189–1216.

Van de Ven, Hans. *Breaking with the past: the Maritime Customs Service and the Global Origins of Modernity in China*. New York: Columbia University Press, 2014.

Wang, Yeh-chien. "Secular Trends of Rice Prices in the Yangtze Delta, 1638–1935." In *Chinese History in Economic Perspective*, edited by Thomas Rawski, and Lillian Li, 35–68. Berkeley: University of California Press, 1992.

Waldron, Arthur. *From War to Nationalism: China's Turning Point, 1924–1925*. Cambridge: Cambridge University Press, 2003.

Wu, Daye, and Hu Yuanzhang. "*Shanghai Jinrong zhi Jijie* (Seasonal in Shanghai Finance)." *Zhengzhi Jingjixue Pinglun* (Review of Political Economics) 5, no. 2 (1937): 471–484.

Wu, Daye. "*Yige Xinde Waihui Zhishu* (A New Exchange Rate Index)." *Zhengzhi Jingjixue Pinglun* (Review of Political Economics) 3, no. 3 (1935): 463–509.

Wu, Leonard. "The Crucial Role of the Chinese Native Banks". *Far Eastern Survey* 4, no. 12 (1935): 89–93.

Wu, Shicheng. *Tianjin Huobi zhi Yiban Qingkuang* (The General Situations of Tianjin's Currency). *Yinhang Zhoubao* (Banker's Weekly) 19, no. 2, January 22, 1935.

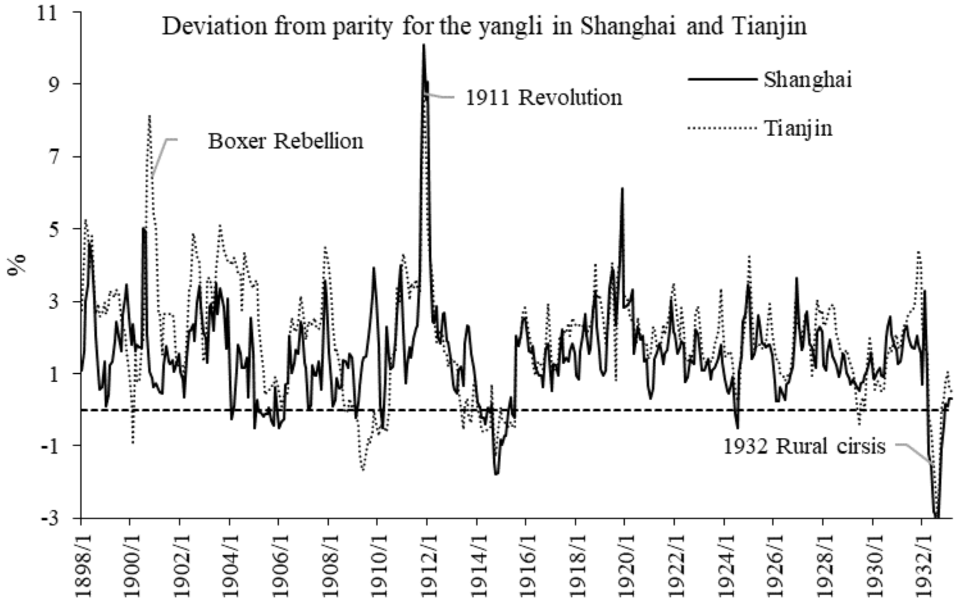
Yang, Yinpu. *Zhongguo Jinrong Lun* (Chinese Finance). Shanghai: Liming Press, 1936.

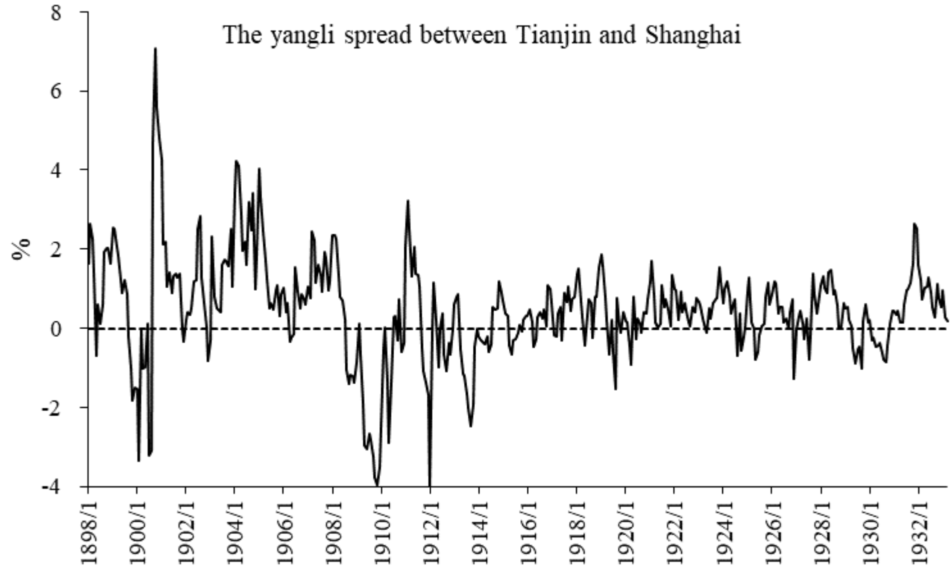
Young, John. "The Shangai Tael." *American Economic Review* 21, no. 4 (1931): 682–684.

Yu, Sun, 1928, "Zhengjin Zhoubao lun Shanghai Yinyuan Liutong Xianzhuang (The Current Situation of Silver Dollar Circulation in Shanghai)" *Yinhang Zhoubao* (Bank Weekly), 12, no. 10 (1928) 26–29.

Zhang, Jiyan. *Zhonghua Bizhi Shi* (A History on Chinese Currency System, vol. 1). Beijing: Zhishi Chanquan Press, 2013.

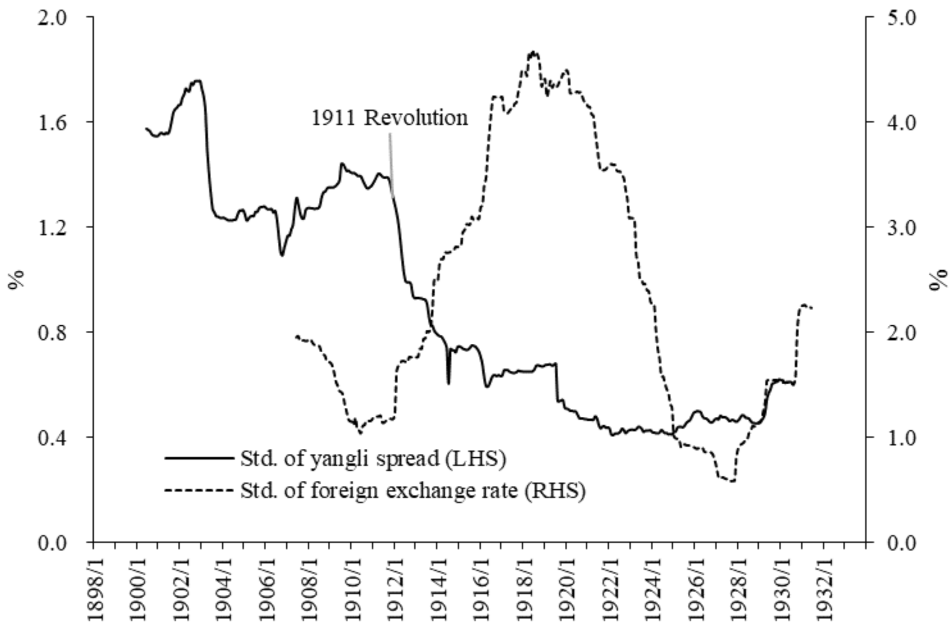
Figure 1. Yangli in Shanghai and Tianjin, monthly data, 01/1898–03/1933.





Notes: The upper panel shows deviation (in percent) from parity for the yangli, and the lower panel measures the yangli spread as the percentage deviation in Tianjin and Shanghai.
Sources: The *Economic Statistics Quarterly* (1935–36).

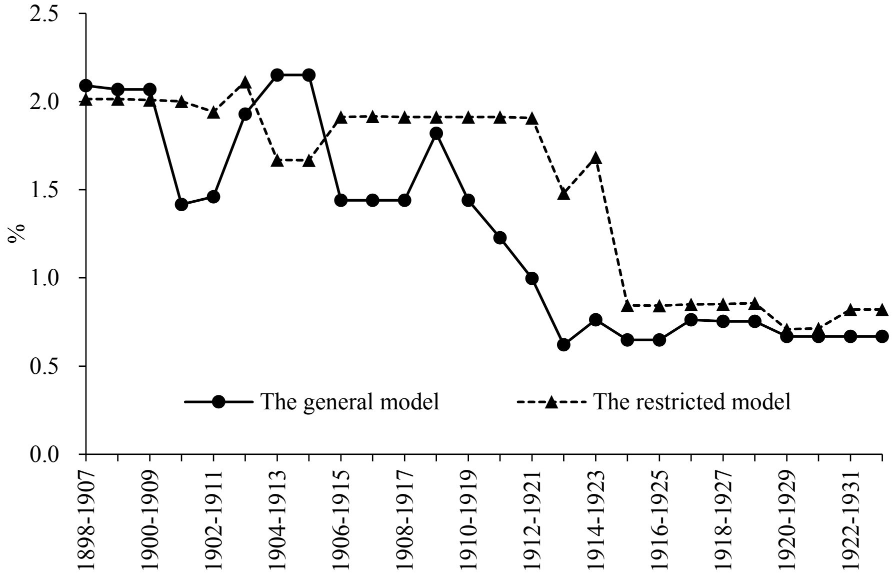
Figure 2. Standard deviations of domestic exchange rate and foreign exchange rate, 60-month moving window, 01/1898–03/1933.



Notes: This figure shows the standard deviations of the yangli spread between Shanghai and Tianjin, and the standard deviations of the foreign exchange rate (deviation from parity) for the Shanghai tael against US dollars. Standard deviation of variable z_t in 60-month moving windows is given by $\sum_{t-29}^{t+30} z_t^2 /60$.

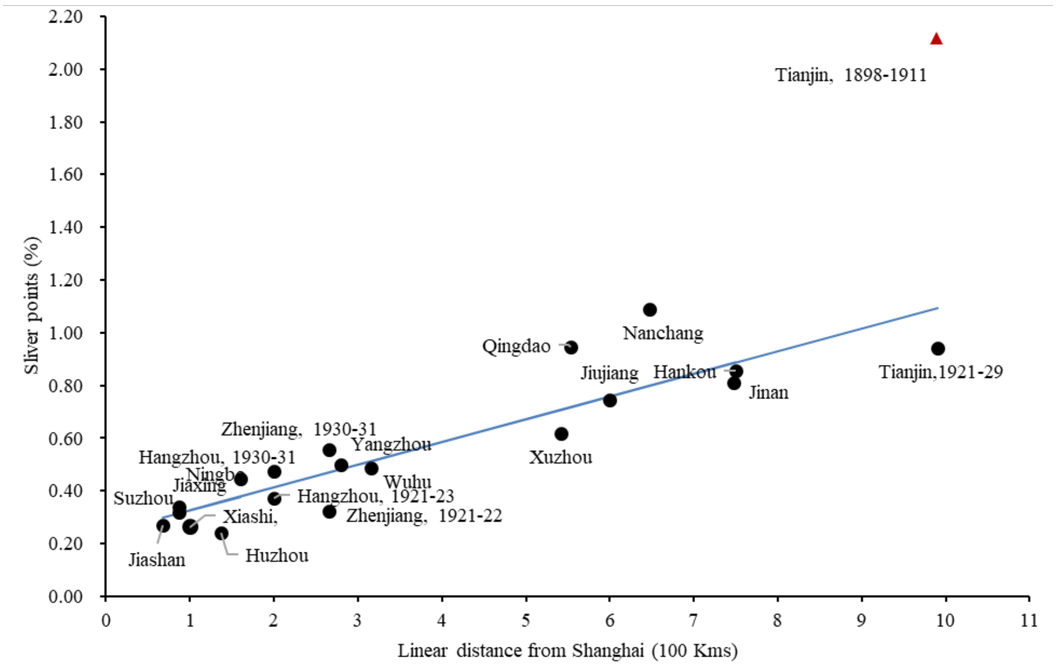
Sources: The data for yangli and foreign exchange rate are taken from the *Economic Statistics Quarterly* (1935–36) and Wu D. (1935), respectively.

Figure 3. Threshold estimates in 10-year moving windows, 01/1898–03/1933



Notes: The solid line and dashed line shows the estimates of silver points from the restricted model and the general TAR model, respectively. The threshold in year t is estimated in a moving window of 120 observations. The window is shifted by 12 months each time.

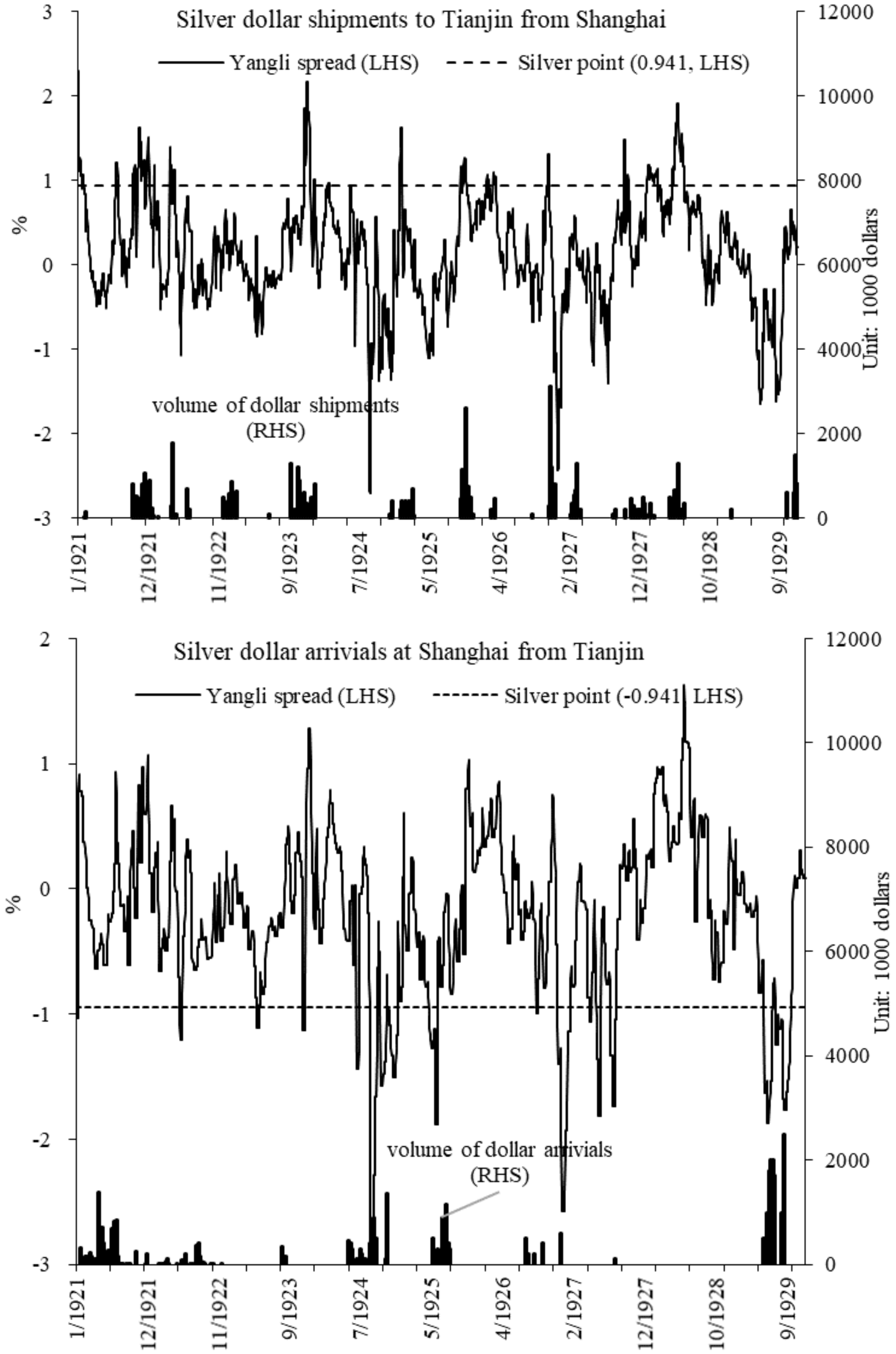
Figure 4. Silver points and distance



Notes: The silver point between shanghai and each of these cities is estimated from a general TAR model as in Eq. (4). Cities not marked with sample period are available for only one period in the 1920s or 1930s. See text for the specific year in each period. The straight line is the OLS regression result of Column 1 in Table 5.

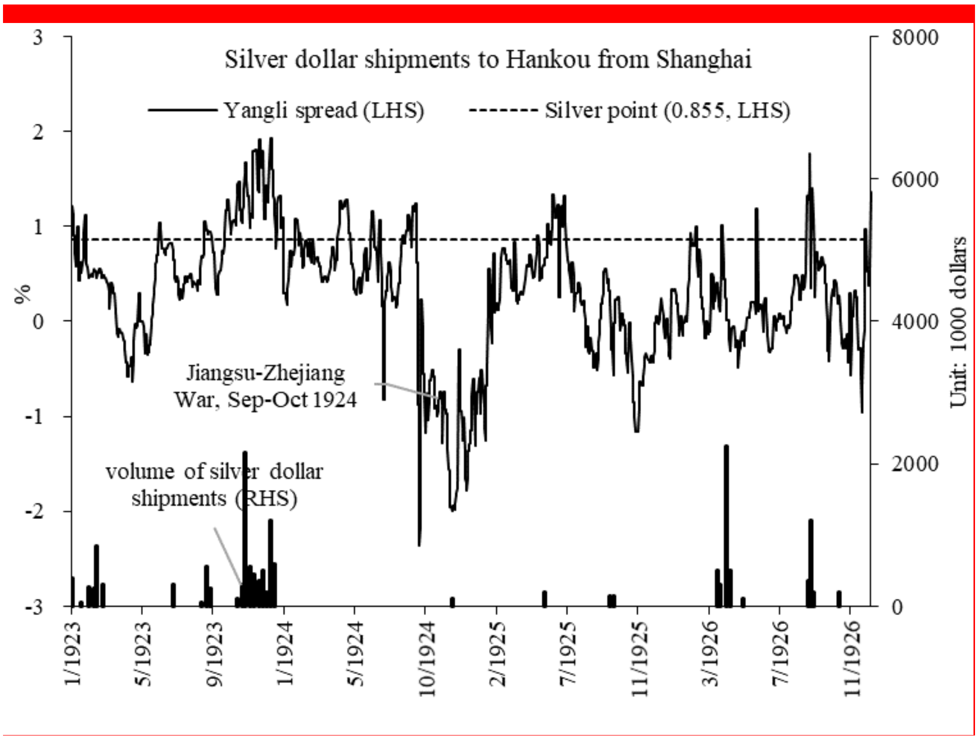
Sources: Daily data for Shanghai is drawn from the *Shanghai Newspaper*, for Tianjin is drawn from the *Bankers' Weekly* and *Economic Statistics*, and for Hankou is drawn from *Bankers' Magazine* and *Economic Statistics*. The data for other cities for the period of 1921–22 is taken from the *Monthly Report of Native Bankers' Association* (1920–22), and for the period of 1930–31 taken from the *Ten-day Bulletin of the Central Bank* (1930–31). The parity ratios between Shanghai *tael* and other local *taels* are taken from Jin (1925).

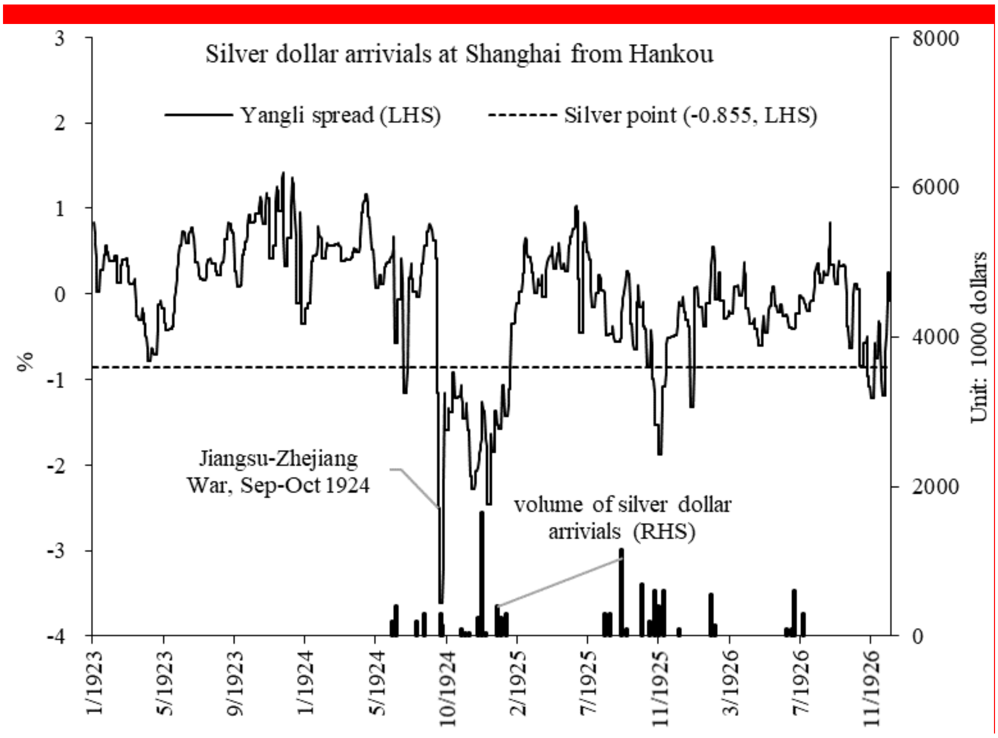
Figure 5. The yangli spread, estimated silver points, and silver dollar flows across Shanghai and Tianjin, 01/1922–12/1929.



Notes: The silver point estimates are from the general TAR model using daily data (±0.941%).
Sources: Daily yangli data is drawn from the *Shanghai Newspaper*, the *Bankers' Weekly* and *Economic Statistics*. Weekly data on the volume of silver dollar movement across Shanghai and Tianjin obtained from the *North-China Herald*.

Figure 6. The yangli spread, estimated silver points, and silver dollar flows across Shanghai and Hankou, 01/1923–07/1926.

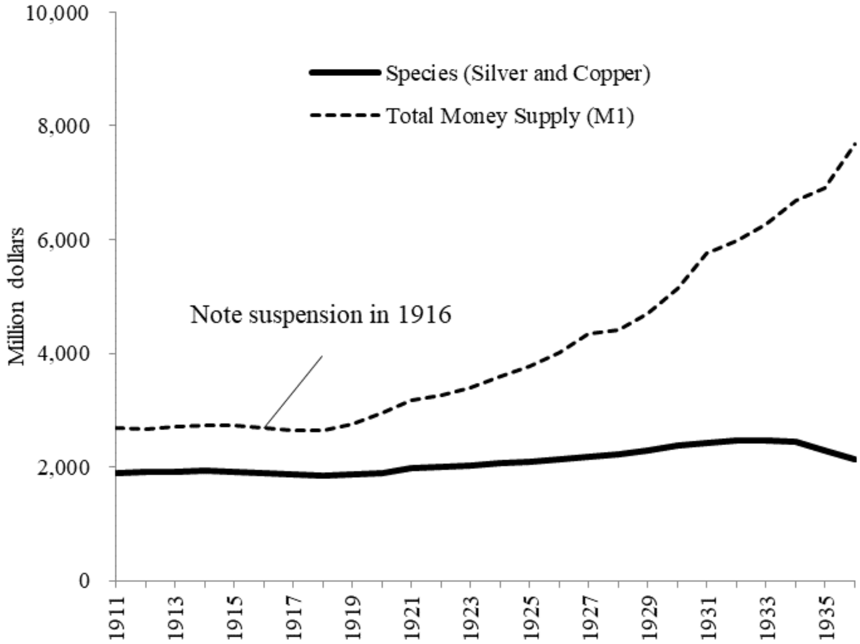




Notes: The silver point estimates are from the general TAR model using daily data (±0.855%).

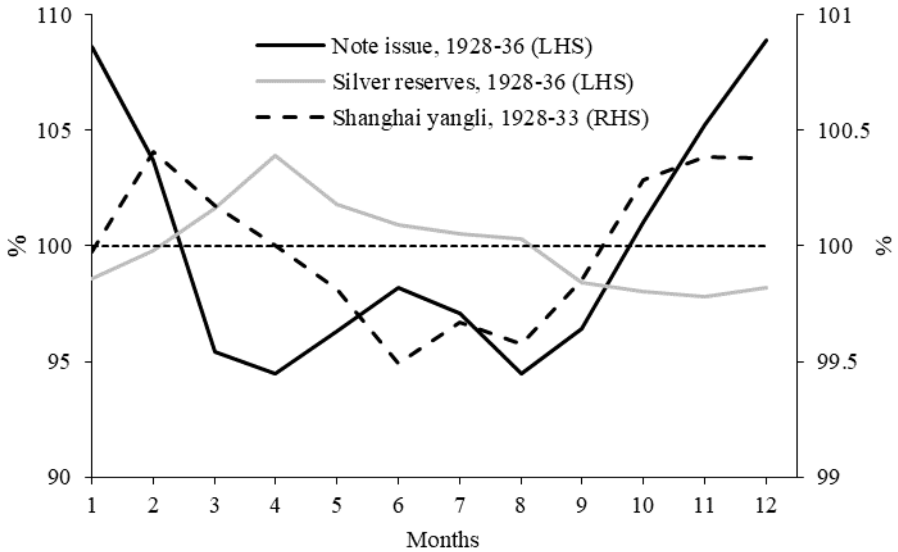
Sources: Daily yangli data is drawn from the *Shanghai Newspaper*, *Bankers' Magazine* and *Economic Statistics*. Weekly data on the volume of silver dollar movement across Shanghai and Tianjin obtained from the *North-China Herald*.

Figure 7. Money supply in China, 1910–35



Note: M1 is equal to species plus bank notes and deposits.
Sources: Bank notes, silver, copper currency from Minami and Makino (2014, Table 5.2.1). Bank deposits data from Rawski (1989, Table C16).

Figure 8. Seasonals in yangli, note issue and silver reserves of banks in Shanghai, 1928–36



Notes: Note issue represents the total volume of the ten biggest banks in Shanghai, including Central Bank, Bank of China and Bank of Communication, etc. Silver reserves is the total reserves of all banks in Shanghai.
Sources: The data on the seasonal patterns in note issue and silver reserves are taken from Wu and Hu (1937). Seasonals in Shanghai yangli are estimated by the authors.

Table 1. The content of pure silver of Chinese currencies

Silver currency	Description	Fine silver (Troy oz.)	Fine silver (gms)	Shanghai tael
Shanghai tael	Unit of account	1.0802	33.5989	
Tianjin tael	Unit of account	1.1398	35.4515	1.0551
Hankou tael	Unit of account	1.1169	34.7413	1.0340
Eagle dollar[1]	Coin	0.7880	24.5101	0.7295
National dollar[2]	Coin	0.7699	23.9475	0.7127

Notes:
1. According to an official assay made by the Chinese Mint at Tianjin, the eagle dollar contains oz. 0.7880 of fine silver, or 0.7295 Shanghai tale at parity (Zhang, 2013, pp. 49–56).
2. The *National Currency Regulations* required that, the national dollar shall contain 23.9779 grams (or oz. 0.7709) of pure silver, and the ratio of the difference between the weight and fineness of silver coins and those of the legal tender shall not exceed 3/1000 (Kann, 1927, p. 163). Assay made by the Japanese Government Mint at Osaka showed that the national dollar actually contains oz. 0.7699 (or 0.7127 Shanghai tales) of pure silver, the error being 1.2/1000 (Kann, 1927, p. 161; Yu, 1928).

Sources: The silver content of Shanghai tael, and the parity of Tianjin tael and Shanghai tael are taken from Young (1931) and Wu (1935). The parity of Hankou tael and Shanghai tael are taken from Jin (1925, p. 9).

Table 2. Restricted (TECM) model, monthly yangli spread between Shanghai and Tianjin

	Full period (01/1898–03/1933)	Sub-periods	
		Qing Empire (01/1898–12/1911)	Republican era (01/1912–03/1933)
θ	2.112 [1.904, 2.331]	2.179 [1.652, 2.524]	0.631 [0. 324, 0.897]
λ	0.067 (0.124)	−0.002 (0.165)	0.426 (0.114)***
k	0.773 (0.175)***	0.796 (0.232)***	0.123 (0.077)
Chan test	17.053**	3.901	18.07***
Q_6	18.811***	13.771**	23.351***
R^2	0.108	0.128	0.154
Log likelihood	−519.792	−249.207	−225.369
σ	0.831	1.082	0.588
Regime (T)			
Upper	34	32	85
Middle	374	122	146
Lower	15	13	24

Notes: Standard errors reported in parentheses. *, **, and *** denote 10%, 5%, and 1% levels of significance, respectively. The 90% asymptotic confidence intervals of threshold θ, calculated using the likelihood ratio approach given by Hansen (1997), reported in brackets. Q_6 is the Ljung-Box statistic up to order 6.

Table 3. TAR model, monthly yangli spread between Shanghai and Tianjin, 01/1898–03/1933

	Full period			Sub-periods					
				Qing Empire (01/1898–12/1911)			Republican era (01/1898–12/1911)		
θ	1.335 [1.276, 1.397]			2.179 [1.904, 2.267]			0.681 [0.598, 1.207]		
T	423								
$logL$	−472.445			−227.45			−208.341		
σ	0.756			0.997			0.557		
Q_6	4.295			5.439			8.725		
Chan test	4.830			8.839			2.065		
Regime	upper	middle	lower	upper	middle	lower	upper	middle	lower
β_0	0.019 (0.232)	0.073 (0.048)	−1.984*** (0.427)	-0.440 (0.571)	0.005 (0.113)	2.274 (2.385)	−0.054 (0.193)	0.088* (0.046)	−0.503** (0.266)
β_1	1.054*** (0.104)	0.687*** (0.083)	0.113 (0.194)	1.162*** (0.184)	0.988*** (0.139)	1.509** (0.758)	0.809*** (0.190)	0.792*** (0.134)	−0.269 (0.221)
β_2	−0.319*** (0.102)	−0.006 (0.076)	−1.289*** (0.204)	-0.286** (0.116)	0.016 (0.112)	-0.190 (0.276)	0.029 (0.109)	−0.138 (0.076)	0.857*** (0.201)
β_3	0.069 (0.077)	0.111* (0.06)	1.396*** (0.180)						
T	75	315	32	32	122	13	76	159	20
$1-\sum_i^n \beta_i$	0.196	0.207	0.780	0.124	-0.004	−0.319	0.163	0.346	0.412

Notes: See Table 2.

Table 4. TAR model, daily yangli spread

	Shanghai-Tianjin (01/1921–12/1929)			Shanghai-Hankou (01/1923–12/1926)		
θ	0.941 [0.940, 0.957]			0.855 [0.808, 0.873]		
T	2589			1356		
$logL$	348.519			−121.175		
σ	0.211			0.265		
Q_{12}	18.103			13.630		
Chan test	13.060			4.522		
Regime	upper	middle	lower	upper	middle	lower
β_0	0.107* (0.057)	0.002 (0.005)	−0.141*** (0.049)	0.072 (0.100)	0.012 (0.009)	−0.211*** (0.075)
β_1	0.814*** (0.064)	0.770*** (0.026)	0.950*** (0.049)	0.616*** (0.104)	0.751*** (0.038)	0.814*** (0.075)
β_2	0.061 (0.069)	0.166*** (0.031)	−0.001 (0.055)	0.059 (0.088)	0.132*** (0.043)	0.173** (0.068)
β_3	−0.025 (0.053)	0.032 (0.024)	−0.107** (0.045)	0.205*** (0.07)	0.083** (0.034)	−0.230*** (0.058)
T	214	2193	182	174	1063	119
$1-\sum_i^n \beta_i$	0.150	0.032	0.158	0.121	0.035	0.243

Notes: See Table 2.

Table 5. Silver points and the distance from Shanghai

Dependent variable: *Silver point (mean=0.557%)*	(1)	(2)
Dis	0.086*** (0.010)	0.063*** (0.012)
d_{BE}		−0.144 (0.089)
$Dis * d_{BE}$		0.018 (0.022)
d_{rail}		−0.009 (0.055)
d_{tras}		0.313*** (0.106)
Constant	0.239*** (0.045)	0.363*** (0.072)
R^2	0.814	0.915
σ	0.117	0.090

Notes: The dependent variable is the silver points between city i and Shanghai. Distance variable (Dis) scaled in 100 km units. Standard errors reported in parentheses. *** denotes 1% level of significance.

Table 6. Probit model, silver dollar flows

	A. Shanghai-Tianjin 01/1921–12/1929		B. Shanghai-Hankou 01/1923–12/1926	
	Shanghai→ Tianjin	Tianjin→ Shanghai	Shanghai→ Hankou	Hankou→ Shanghai
d_{ys}	0.613*** (0.117)	0.391*** (0.124)	0.585*** (0.166)	0.791*** (0.174)
d_{aut}	0.375*** (0.105)	−1.142** (0.465)	0.216 (0.222)	0.197 (0.234)
d_{war}	−0.099 (0.128)	−0.356** (0.163)	−0.078 (0.327)	−0.325 (0.339)
Constant	−1.959*** (0.062)	−1.760*** (0.054)	−2.166*** (0.098)	−2.193*** (0.099)
McFadden - R^2	0.050	0.030	0.053	0.071
LR	40.67 [<0.01]	23.63 [<0.01]	16.57 [<0.01]	20.83 [<0.01]

Notes: The dependent variable is an indicator representing the occurrence of silver flow, and → shows the direction of silver flow. Standard errors and p-values reported in parentheses and brackets, respectively. **, and *** denote 5%, and 1% levels of significance, respectively. d_{ys} is an indicator representing the instance of yangli spread which exceeds our preferred silver point estimate. d_{aut} and d_{war} are indicators representing the agricultural trade season and major military conflicts. LR (Likelihood Ratio) statistic is used to test the joint null hypothesis of all the coefficients except the intercept are zeros.